

Class 4 Habitat

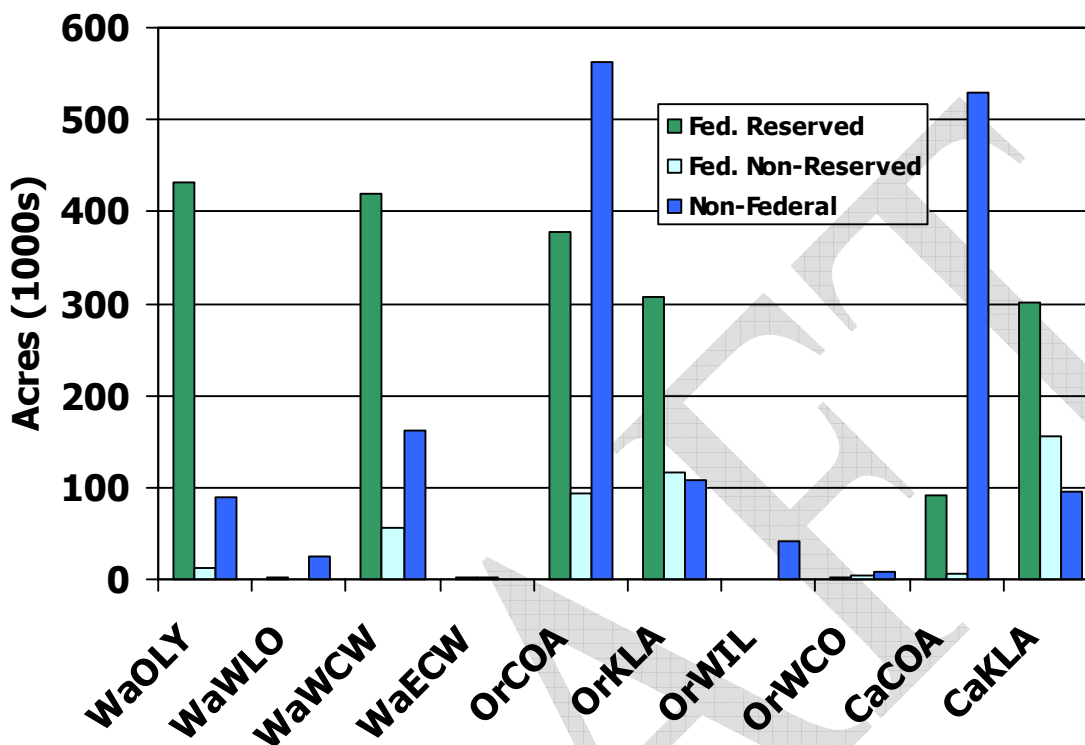


Figure 7. Estimated amounts of potential Marbled Murrelet nesting habitat by province for non-federal lands, and reserved or non-reserved federal lands. Murrelet conservation zones 1 and 2 are represented. Habitat estimates are derived from the highest suitability class (Class 4) from the Expert Judgment model. See Figure 1 for locations and abbreviations of physiographic provinces.

Figure 8.

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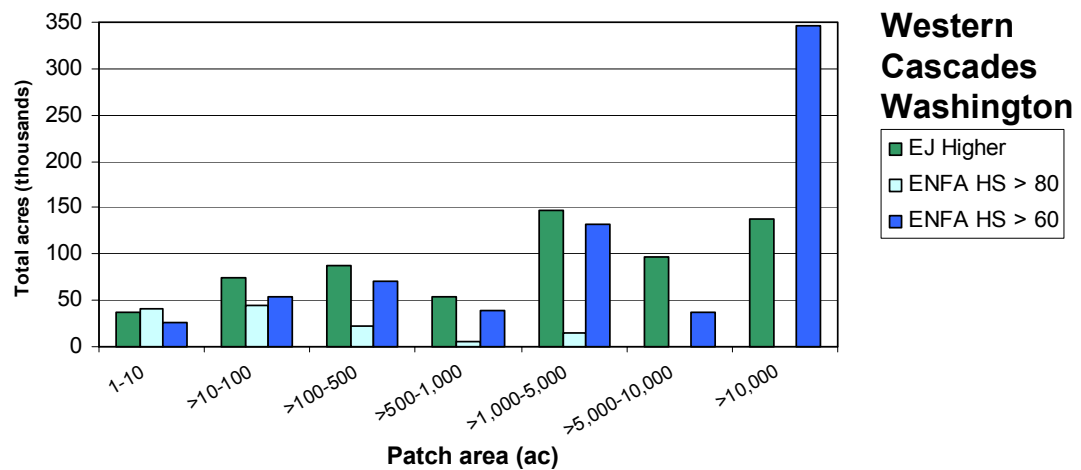
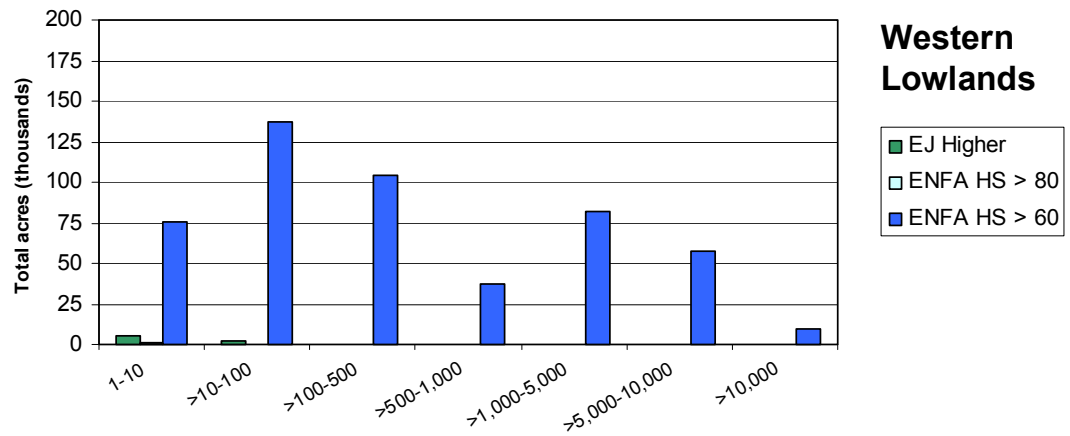
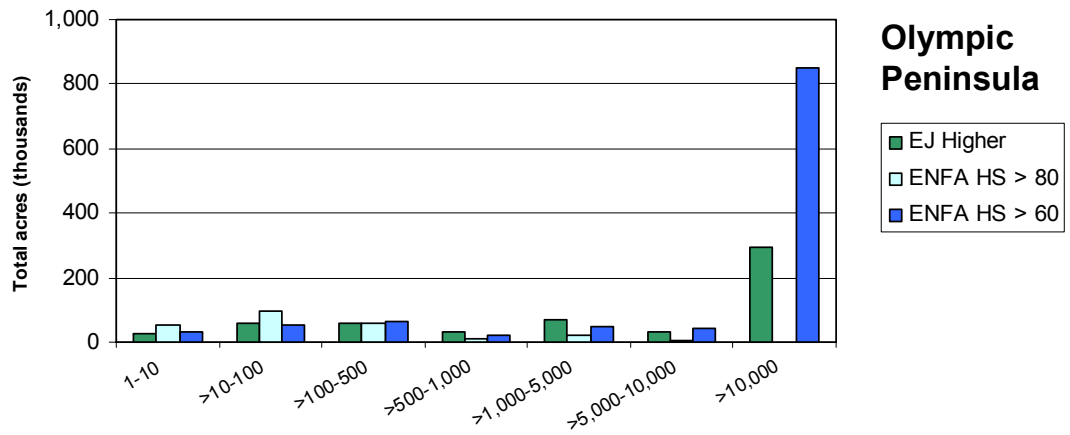
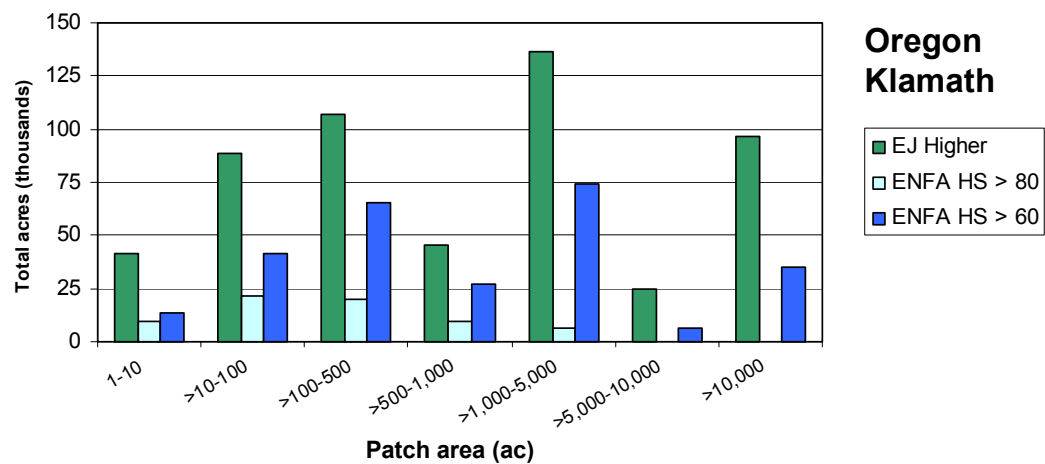
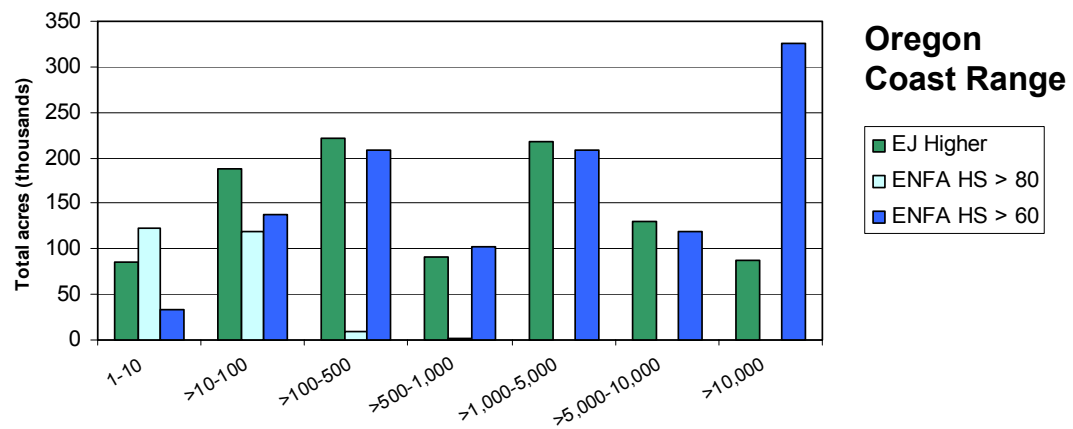
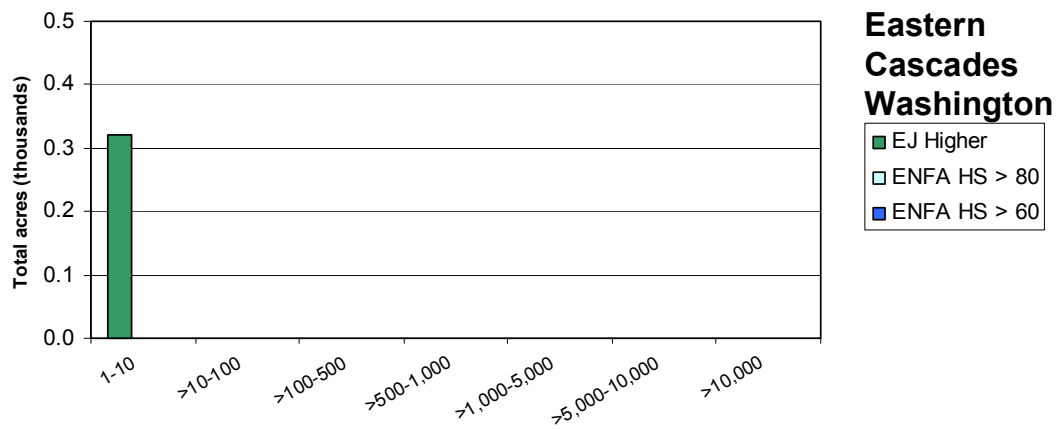


Figure 8. (Continued)

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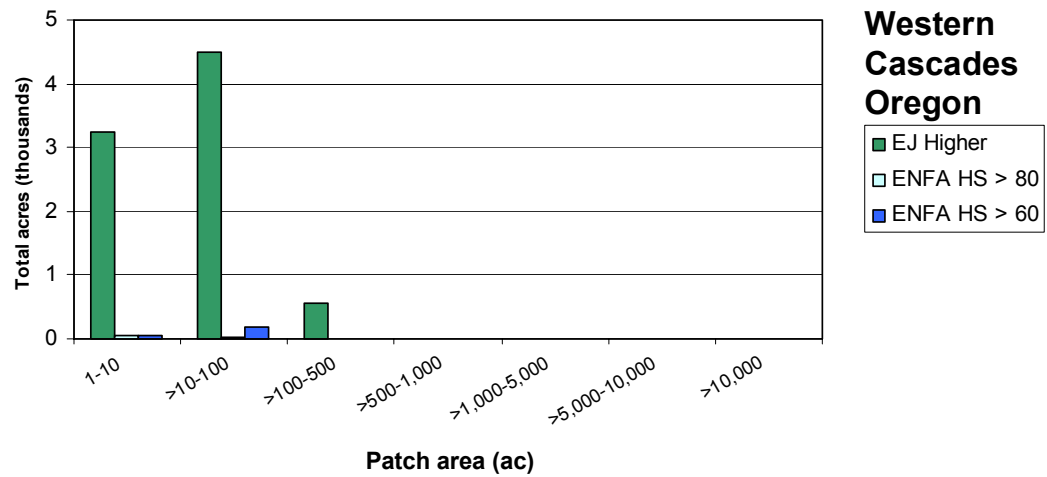
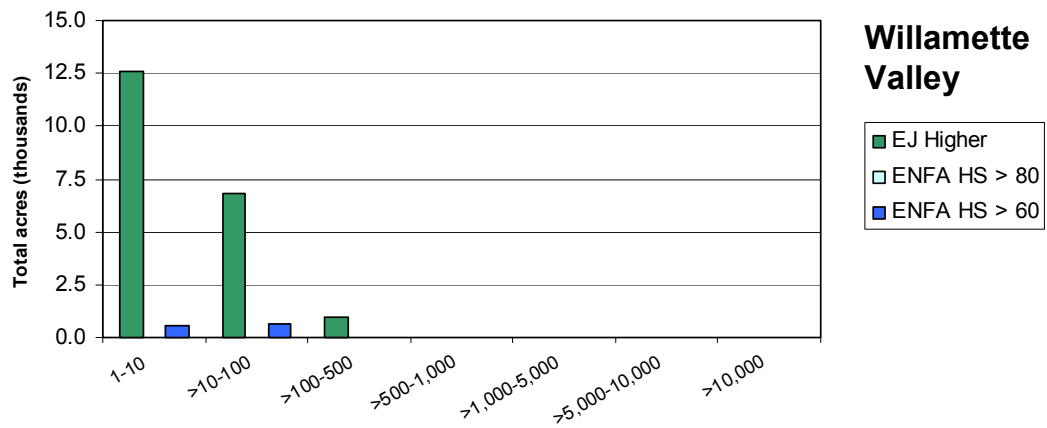


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Figure 8. (Continued)

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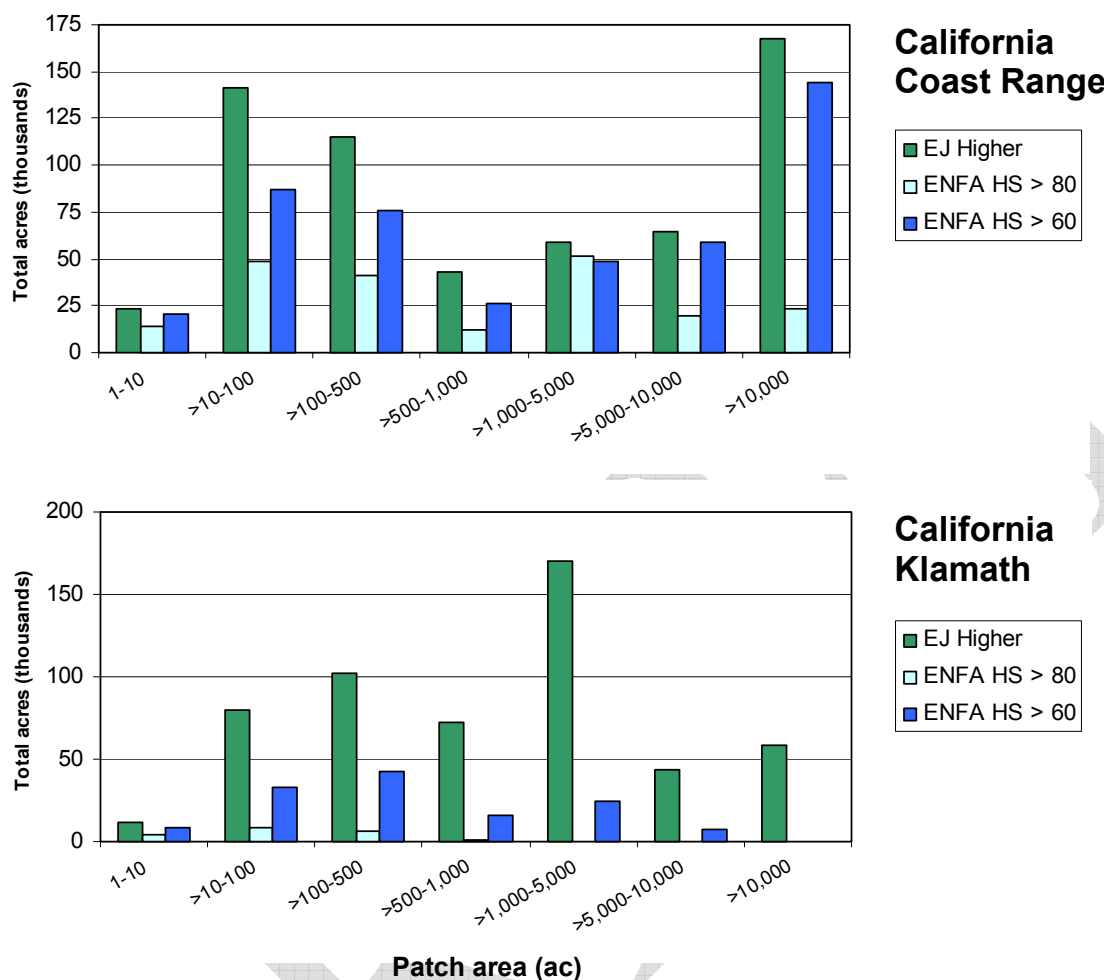


Figure 8. Acres of potential Marbled Murrelet nesting habitat in relation to size of patch in each physiographic province. Habitat was classified using two modeling approaches, Expert Judgment (EJ) and Ecological Niche Factor Analysis (ENFA). See text for details.

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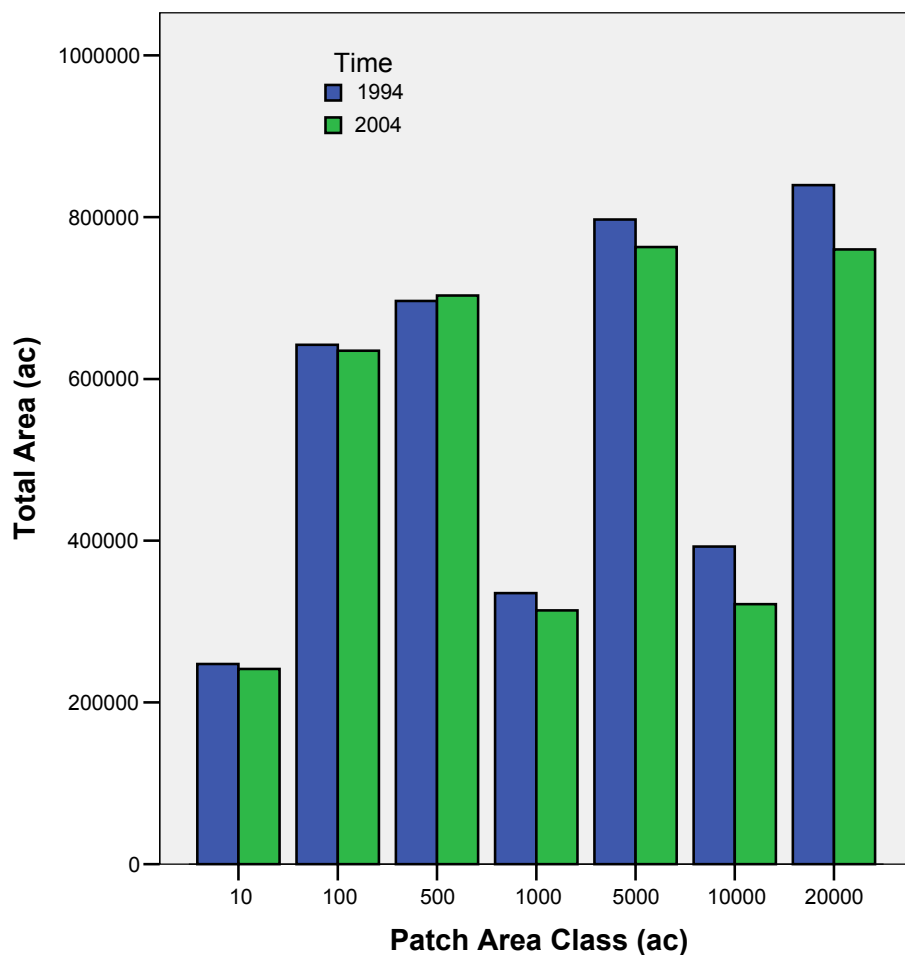


Figure 9. Change in total acres of Class 4 habitat (as estimated using the Expert Judgment model) from 1994 to 2004 by patch size class, pooled over all provinces. Values of patch size indicate upper limit of ranges for each class.

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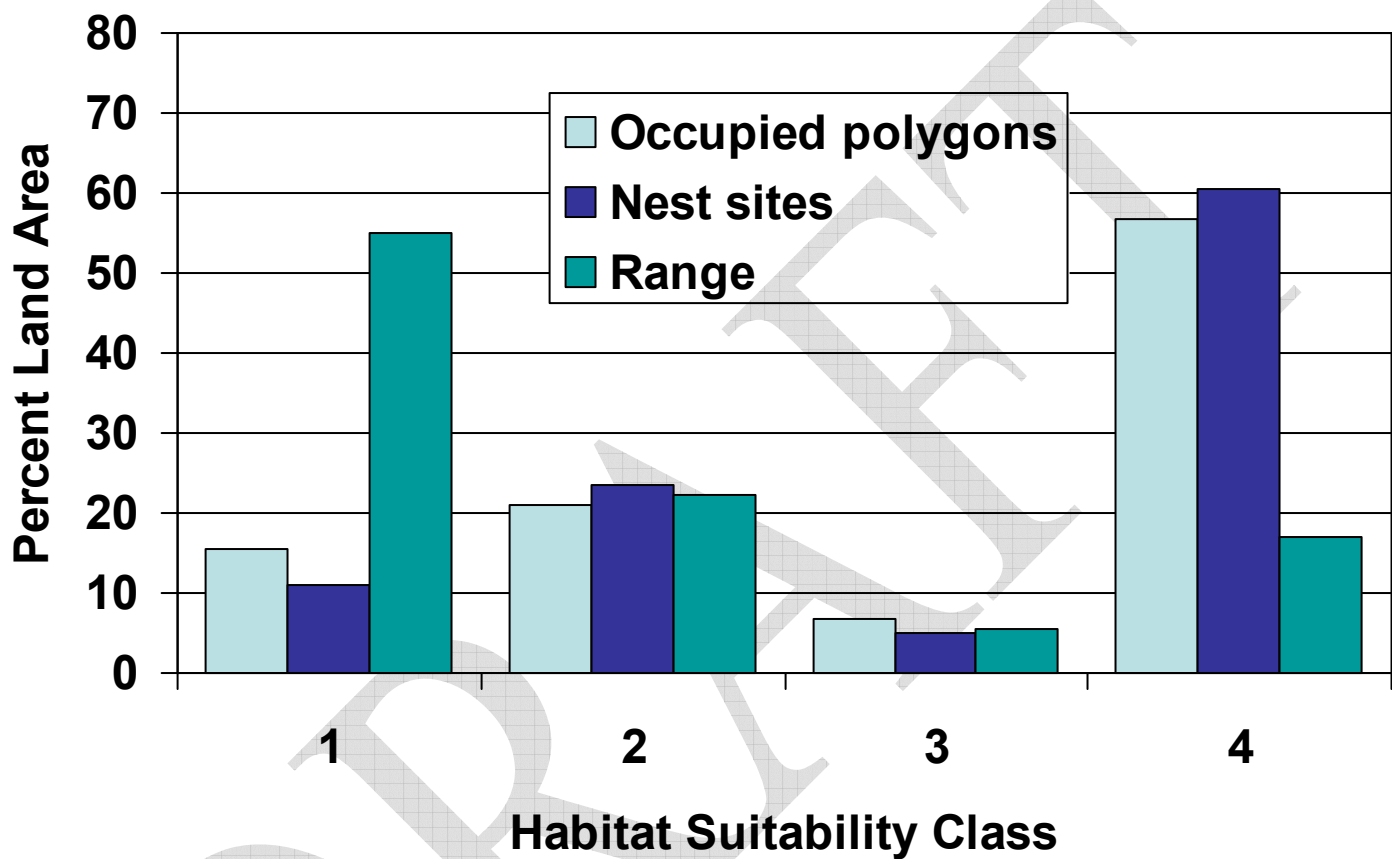


Figure 10. Frequency distributions of habitat suitability classes for all habitat capable lands within Murrelet Zone 1 (range), for occupied polygons, and for active nest sites. Habitat suitability classes are defined using the Expert Judgment model following criteria in Table 1.

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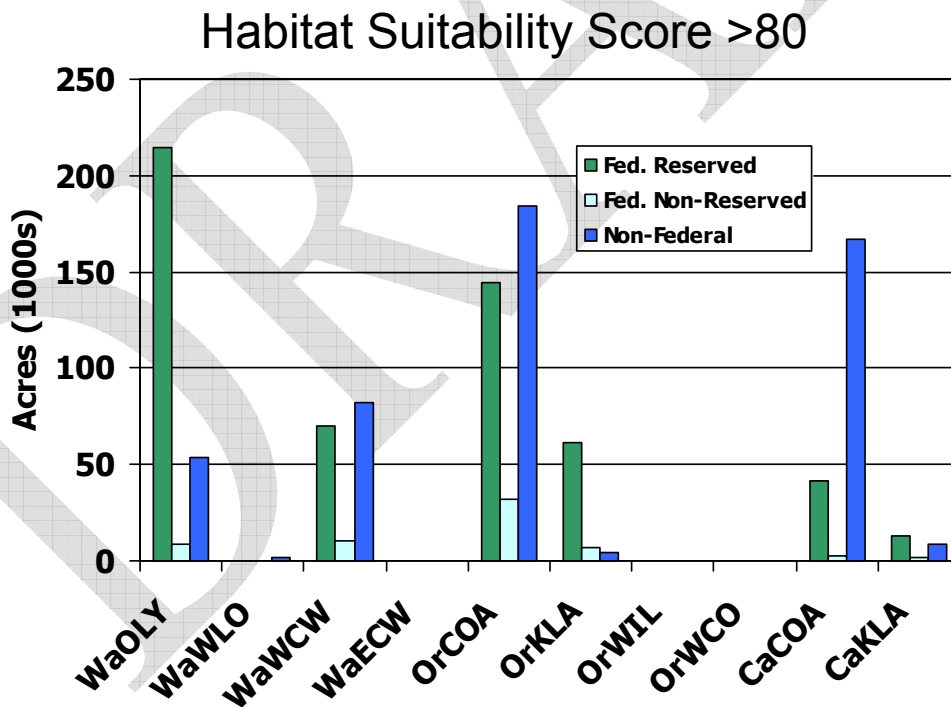
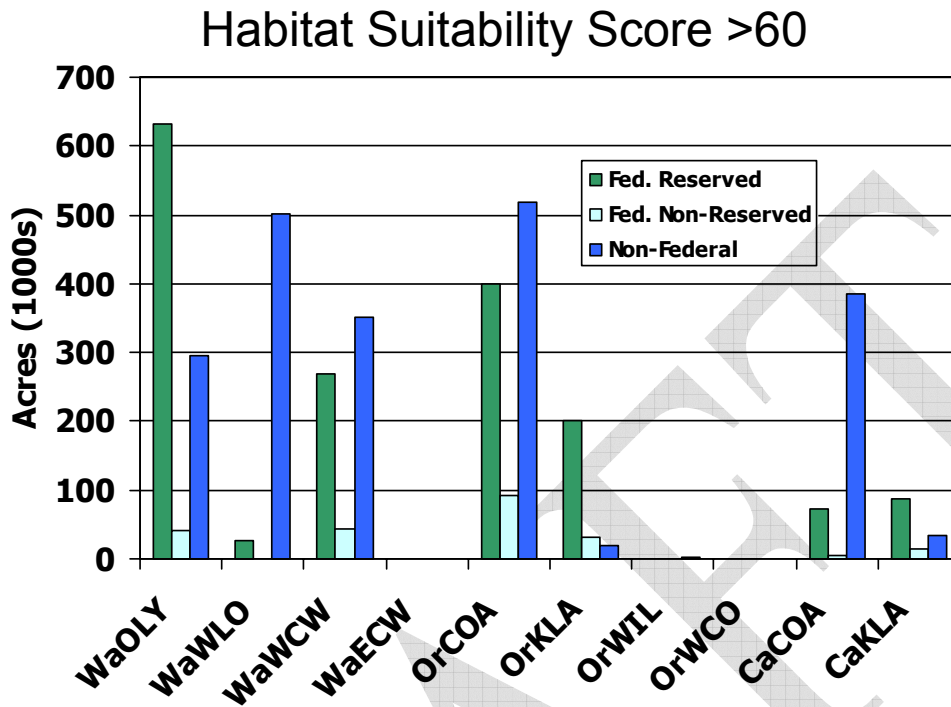


Figure 11. Acres of potential Marbled Murrelet nesting habitat by province for non-federal lands, and reserved or non-reserved federal lands as estimated from Ecological Niche Factor Analysis.

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Upper figure shows amounts with habitat suitability scores >60; lower figure shows amounts with suitability score >80. All estimates apply only to Marbled Murrelet Zone 1. See Figure 1 for locations and abbreviations of physiographic provinces.

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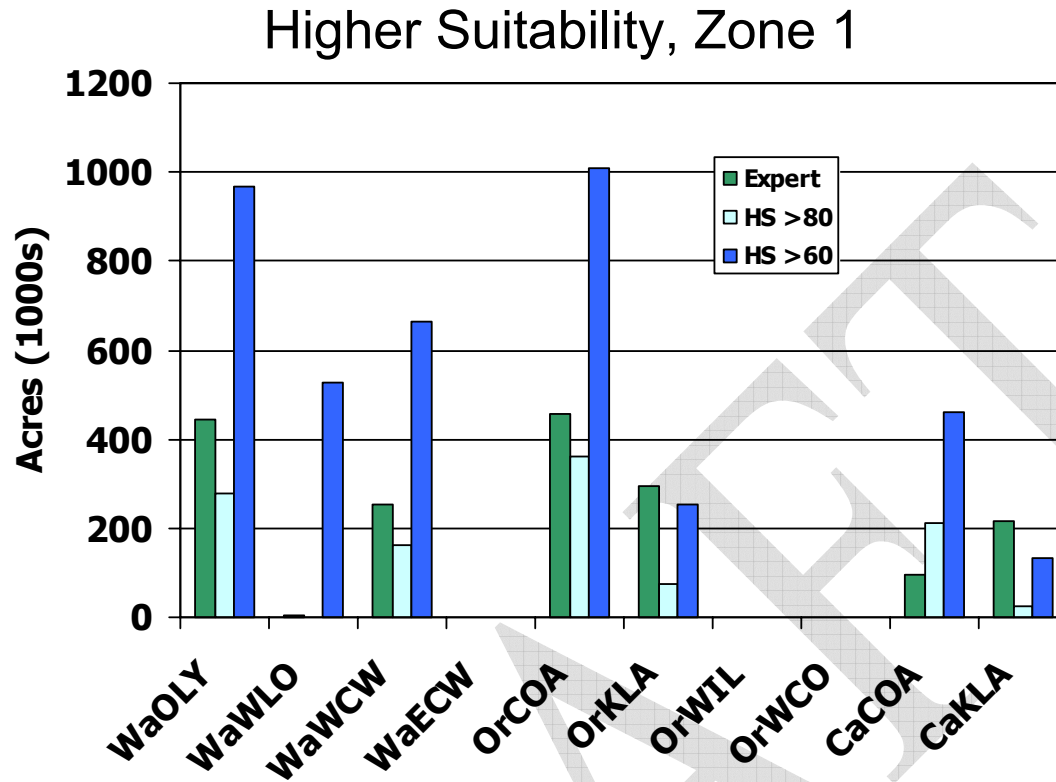


Figure12. Comparison of acres of potential Marbled Murrelet nesting habitat for federal lands for the Expert Judgment model (acres classified as Class 4 habitat suitability) and for the ENFA models (acres classified using suitability scores >60 and >80) for Marbled Murrelet Zone 1. The Eastern Cascades of Washington was omitted from ENFA analysis as Marbled Murrelet Zone 1 does not occur in that province. See Figure 1 for locations and abbreviations of physiographic provinces.

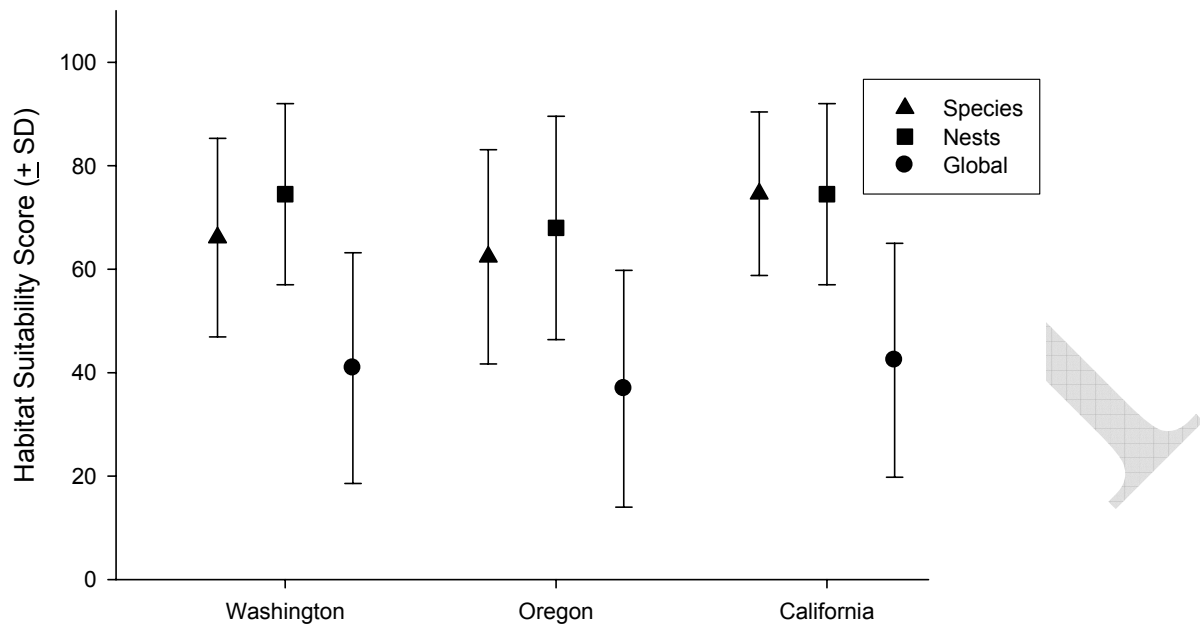


Figure13. Comparison of mean habitat suitability scores computed from the set of occupied polygons (“Species”, n = 111), known Marbled Murrelet nests (“Nests”, n = 79) and across all lands in each state (“Global”).

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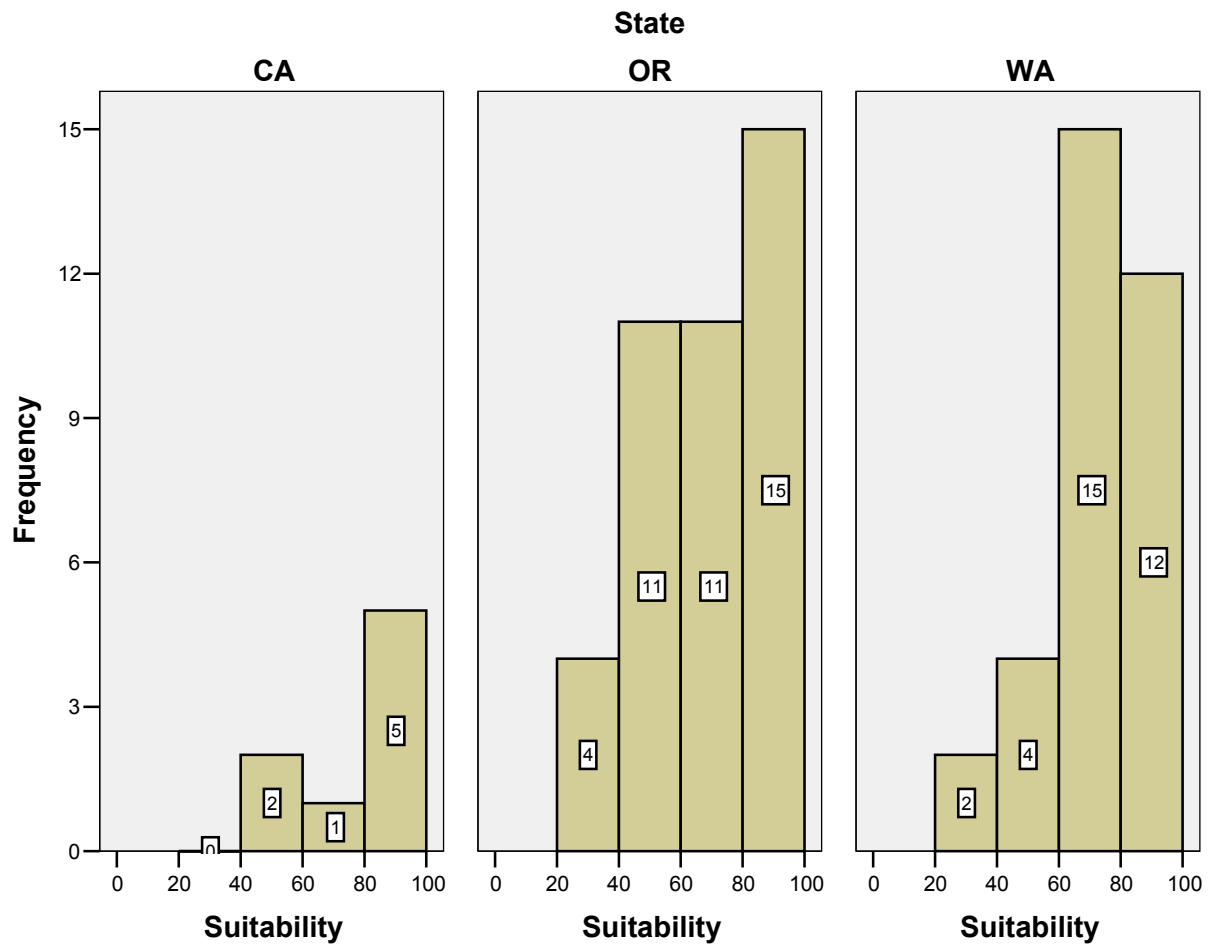


Figure14. Frequency distribution of habitat suitability scores at known Marbled Murrelet nest sites, by state.

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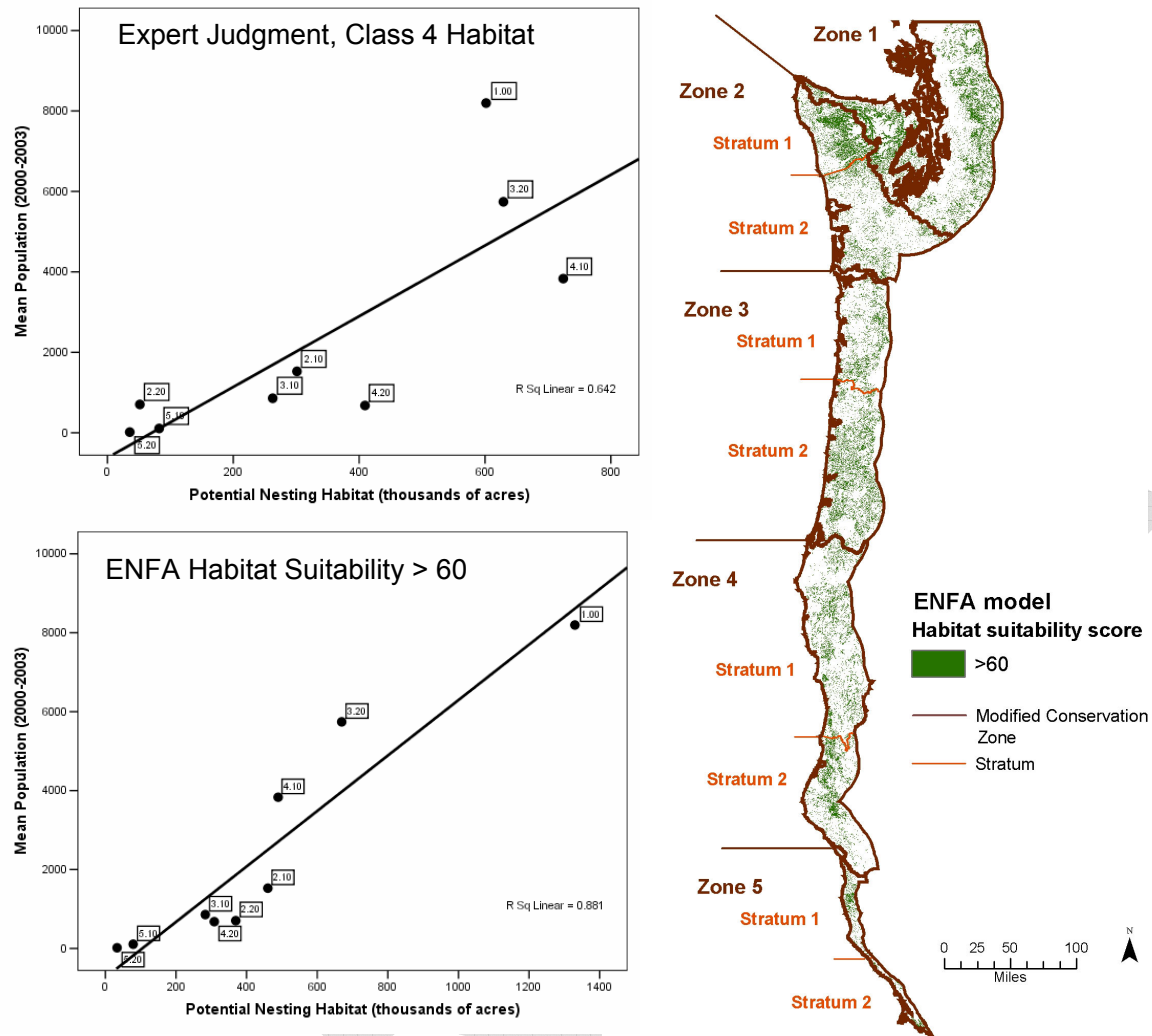


Figure 15. Comparisons of estimates of mean murrelet population size with potential baseline murrelet nesting habitat from Expert Judgment model (above) and Ecological Niche Factor Analysis (ENFA) model (below) for all lands in Marbled Murrelet Zone 1 by modified Conservation Zones 1 through 5 and by stratum within zones (e.g., 2.1 denotes Conservation Zone 2, Stratum 1). The delineation of zones and strata are illustrated in the map (which depicts habitat with HS >60 from the ENFA model). See Miller et al. Chapter 3, in press, for a description of methods used to estimate murrelet population size. For Zone 1, populations could not be separated among strata, so the entire zone is plotted as 1.0.

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SUMMARY

The Marbled Murrelet (*Brachyramphus marmoratus*) was federally listed in 1992 as threatened in Washington, Oregon, and California. The Northwest Forest Plan (Plan), which overlaps the Murrelet's range in these three states identifies specific objectives and standards and guides to provide for persistence of this species. Because a conservation objective of the Plan was to support stable and well-distributed populations of Marbled Murrelets, this species is a key indicator of the Plan's potential success. The effectiveness monitoring approach for the Marbled Murrelet under the Plan, with two facets: population and habitat monitoring. The approach recommends assessing population trends at sea using a unified sampling design and standardized survey methods. For the habitat monitoring, the approach recommends establishing a credible baseline of nesting-habitat data by modeling habitat relations, and then using the baseline to track habitat changes over time. The Plan identified one primary monitoring objective: to determine the status and trend of Marbled Murrelet populations and nesting habitat in the Plan area.

The chapters in this volume summarize information on Marbled Murrelet ecology and present the monitoring results for Marbled Murrelets over the first 10 years of the Plan, 1994 to 2003. The first two chapters provided context and background information to support subsequent chapters: Chapter 3 presents population status and trend results from 2000 to 2003 and Chapters 4 and 5 present nesting habitat status and trends

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using different modeling approaches. Chapter 4 is not available for this dissemination of information.

In Chapter 2, we summarized the literature on the natural history, behavior, habitat associations and population status and trends of the Marbled Murrelet. Marbled Murrelets are non-colonial, secretive alcids that occur along the Pacific Coast of North America. They are generally non-migratory and remain near nesting areas year round, especially in the southern portion of their range. Murrelets primarily nest in trees in coastal older-aged coniferous forests within 52 miles of the ocean. Their breeding season lasts up to 182 days (between April and September) and is highly asynchronous. They do not build a nest, but lay their single egg on platforms created by large or deformed tree branches. Key components of their nesting habitat at the tree and stand scales included large platforms or tree limbs with substrate (generally moss) and cover, high densities of large trees, canopy layering, and naturally occurring canopy gaps to allow access to nest sites. At the landscape scale, murrelet nesting and occupied detections have generally been associated with unfragmented watersheds, large patch size, and minimal edge. Few associations with respect to topographic features, such as elevation, slope, aspect, and distance to marine waters, have been found. Rough estimates of the current population based on at-sea surveys are as high as 950,000 birds. Major population declines over a decade or more have been reported.

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In Chapter 3, we reported the first Plan-wide population estimates for the Marbled Murrelet using consistent and standard statistical survey methods, which were developed and implemented through the Plan Effectiveness Monitoring Program. To estimate Marbled Murrelet population size, we sampled from boats using line transects within 8 km of the Washington, Oregon, and northern California coastline, covering ~8,800 km². From 2000-2003, we estimated that the population size of Marbled Murrelets at sea is ~22,000 birds (on any single day) for the coastal waters adjacent to the Plan. The 95% confidence interval for the population size ranges from ~18,500-29,000 birds. For the four years of surveying Marbled Murrelets, we concluded that Marbled Murrelet populations did not change significantly. We estimated that 6 years of at-sea surveys are needed to detect a 10% annual population decline in the coastal water adjacent to the Plan with 95% confidence, and 9 years for a 5% and 15 years for a 2% change. The largest population estimate was in the Puget Sound and Strait of Juan de Fuca of Washington; the highest densities were along the coast of Oregon and California, north of the Humboldt-Mendocino county line, and the smallest population and lowest density were from the Humboldt-Mendocino county line south ~200 mi to San Francisco Bay, California.

In Chapter 4, we used the survey location data to develop logistic regression equations to predict nesting sites that had habitat attributes similar to those of occupied sites.

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Then, we used these equations to predict the baseline amount of nesting habitat by using habitat data from a systematic inventory grid that covers federal lands in the Plan area. We consider this approach experimental in our quest to develop new methods to monitor long-term habitat change that are repeatable, effective, and cost efficient.

Our logistic regression model predicted that murrelet nesting habitat is more likely at sites that are closer to the sea, are on relatively flat terrain, are topographically cooler, have relatively fewer conifers above pole size (≥ 10 in dbh), have greater basal area of trees above pole size, and that have greater basal area of larger-diameter trees (> 30 in dbh). Overall, our models predicted that a majority of acres on U.S. Forest and Bureau of Land Management Lands in the Plan area have low odds ratios of suitable nesting habitat for Marbled Murrelets relative to that of known nesting habitat. Habitat with the higher odds ratios (higher suitability for nesting) by state was highest in Washington, by physiographic province was highest in the Oregon Coast Range and Olympic Peninsula. While most of habitat area with higher-suitability was in a reserve land allocation, most of reserved land had low odds ratios of being suitable for nesting relative to that known nesting habitat. Only 13% of US Forest Service and Bureau of Land Management land had odds ratios that were equal to or exceeded that of known occupied nesting habitat. To shift from experimental to broader applications, our primary recommendation is to substantially increase the number of murrelet survey sites available to make predictions and to restrict the modeling only to where Murrelets are known to nest.

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In Chapter 5, we reported estimates of the amount and distribution of Marbled Murrelet nesting habitat using interpreted satellite imagery. We used two spatial modeling approaches: expert judgment and ecological niche factor analysis. With the expert judgment approach, we reclassify 22 previously established late-successional and old-growth forest classes into 4 classes of murrelet nesting habitat suitability and mapped them. With the ecological niche factor analysis approach we computed habitat suitability scores from vegetation and physiographic attributes based on comparisons of conditions at 111 sites that were occupied by Marbled Murrelets and average conditions over the physiographic provinces in which the murrelets occurred. Our estimates of potential nesting habitat at the province scale differed from those previously described in the Plan: higher in Washington Western Cascades, Oregon Coast Range, and California Coast Range and lower in Olympic Peninsula, Oregon Klamath, and California Klamath. Estimates of amounts of baseline habitat varied with the model used, but all models showed that over 80 percent of baseline habitat on federally-administered lands occurred in reserved lands. In reserved lands including National Parks, Washington had the highest amount of high-quality habitat, 44% of the total; Oregon and California had 36 and 20%, respectively from expert judgment model. Likewise, using the Ecological Niche Factor Analysis the totals were 55%, 36%, and 9%, respectively. The Olympic Peninsula province accounted for nearly a quarter of the high-quality habitat on federally-administered lands; this habitat was primarily in National Parks. Across all lands in the Plan area, we estimated that ~50% of higher-

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quality potential nesting habitat occurred on non-federal lands. Of the two Marbled Murrelet Inland Management Zones in the Plan, the Zone furthest from the coast, Zone 2, accounted for <2% percent of the estimated high-quality habitat on federally-administered lands. Potential nesting habitat was lost to fire and harvest in the first 10 years of the Plan; the rate of habitat loss was higher on non-federal lands. In-growth of large-diameter stands has also occurred and rates of in-growth appear to exceed rates of loss of such stands but we are uncertain how much of this in-growth can be considered nesting habitat.

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